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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
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| 10/006,578 | 12/06/2001 | Manoj K. Jain | TI-31858 | 4968 |

23494 7590 10/05/2005

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| EXAMINER |
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LE, THAO X

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| ART UNIT | PAPER NUMBER |
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2814

DATE MAILED: 10/05/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

H.B

Office Action Summary

Application No.

10/006,578

Applicant(s)

JAIN, MANOJ K.

Examiner

Thao X. Le

Art Unit

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 01 September 2005.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1,4-9 and 11-16 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1,4-9 and 11-16 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claims 1, 4-9, 11-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over US Patent 6291340 to Sandhu et al. in view of US 6693030 to Subrahmanyam et al.

Regarding to claims 1, 4, Sandhu discloses a method of forming a conductive structure in an integrated circuit in Fig. 1, comprising the steps of: forming a dielectric layer 32, column 6 line 57, over a semiconductor body 34, column 6 line 1, forming a hole 31, column 6 line 65, fig. 3, in dielectric layer 32, forming a conductive liner 35, column 7 line 1, in hole 31, annealing conductive liner, column 7 lines 16-19, then forming a conductive barrier 41, column 7 line 13, fig. 4, filling hole 131 with a conductive material 62, column 7 line 30.

But, Sandhu does not expressly disclose after annealing conductive liner, treating conductive liner with plasma hydrogen to reduce a native oxide that form on conductive liner.

However, Subrahmanyam reference discloses a method wherein the conductive liner titanium or TiN, column 8 line 22, is being treated with plasma

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comprises hydrogen, column 8 line 15-18 and 24, to reduce a native oxide that form on conductive liner, column 3 lines 34-36 and column 7 lines 1-5. At the time the invention was made; it would have been obvious to one of ordinary skill in the art to use the method of treating titanium film with hydrogen plasma of Subrahmanyam to treat the conductive film 35 of Sandhu, because such hydrogen plasma treatment would have remove the oxide and contaminant on the surface of the conductive layer and to improve the electro migration resistance as taught by Subrahmanyam, column 3 lines 1-15 and 50-54. Also, McDevitt is disclosing such improvement for titanium layer having similar two step annealing process in column 7 lines 1-20.

Regarding to claims 5-7, 12-15, Sandhu does not disclose the method wherein the hydrogen containing atmosphere comprises pure hydrogen or hydrogen mixed with a carrier gas.

But, Subrahmanyam reference discloses the method where the hydrogen containing atmosphere comprises pure hydrogen or hydrogen mixed with a carrier gas or ammonia, column 7 line 58. At the time the invention was made; it would have been obvious to one of ordinary skill in the art to use the method of treating titanium film with hydrogen plasma of Subrahmanyam to treat the conductive film 35 of Sandhu, because such hydrogen plasma treatment would have remove the oxide and contaminant on the surface of the conductive layer and to improve the electro migration resistance as taught by Subrahmanyam, column 3 lines 1-15 and 50-54.

With respect to ammonia, the mixture of hydrogen and nitrogen gas would react and result in ammonia gas.

Regarding claims 8, 16, 11 Sandhu does not disclose the method further comprising the step of repeating treating step prior to filling step.

But Subrahmanyam reference discloses the method as discuss in the above claim 1 can be done before or after deposition of the barrier layer, column 3 line 51-52, prior to filling step, column 8 line 7. At the time the invention was made; it would have been obvious to one of ordinary skill in the art to use the method of treating titanium film with hydrogen plasma of Subrahmanyam to treat the barrier film 41 of Sandhu, because such hydrogen plasma treatment would have remove the oxide and contaminant on the surface of the conductive layer and to improve the electro migration resistance as taught by Subrahmanyam, column 3 lines 1-15 and 50-54.

Regarding to claim 9, Sandhu discloses a method for forming a contact in an integrated circuit, comprising the steps of: forming a dielectric layer 32, column 6 line 57, over a semiconductor body 34, etching a contact hole 31, column 6 line 65, fig. 3, extending through dielectric layer 32, deposited titanium 35, column 7 line 1, in hole 31, over dielectric layer, including on exposed surface with contact hole, annealing titanium, column 7 lines 16-19, then deposit TiN 41, column 7 line 13, fig. 4, over titanium, and then filling contact hole 131 with a tungsten 62, column 7 line 30.

But Sandhu does not expressly disclose the method comprising treating titanium with hydrogen prior to annealing step to reduce a native oxide that form on titanium.

However, Subrahmanyam reference discloses a method wherein the conductive titanium or TiN, column 8 line 22, is being treated with plasma comprises hydrogen, column 8 line 24, to reduce a native oxide that form on conductive film, column 3 lines 34-36 and column 7 lines 1-5. At the time the invention was made; it would have been obvious to one of ordinary skill in the art to use the method of treating titanium film with hydrogen plasma of Subrahmanyam to treat the conductive film 35 of Sandhu, because such hydrogen plasma treatment would have remove the oxide and contaminant on the surface of the conductive layer and to improve the electro migration resistance as taught by Subrahmanyam, column 3 lines 1-15 and 50-54. Also, McDevitt is disclosing such improvement for titanium layer having similar two step annealing process in column 7 lines 1-20.

Response to Arguments

3. Applicant's arguments filed 01 Sept 2005 have been fully considered but they are not persuasive. The Applicant argues that Subrahmanyam does not disclose performing its pre-cleaning between the liner and barrier depositions. Thus, there is no disclosure or suggestion in the reference of forming a conductive liner in a hole, annealing the conductive liner, after annealing the conductive liner, treating the

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conductive liner with hydrogen and then forming a conductive barrier over the conductive liner as required by claims 1 and 9. The examiner submits that Sandhu discloses all the limitations as cited except treating the conductive liner with hydrogen prior to deposit the conductive barrier as discussed above. In addition, Subrahmanyam discloses pre-cleaning with hydrogen the conductive Ti or Ti/TiN can be performed both before and after deposition, column 8 lines 15-20 and 30. Thus, by using the teaching of pre-cleaning Ti or Ti/TiN layer with hydrogen of Subrahmanyam to pre-cleaning the conductive liner 35 of Sandhu does not change the principle of operation of the primary reference or render the reference inoperable for its intended purpose. See MPEP § 2143.01. In fact, by pre-cleaning the conductive liner would have reduced the amount of contaminant and improved the electro migration resistance of the feature as taught by Subrahmanyam, column 3 lines 50-55. Furthermore, the test for obviousness is not whether the features of a secondary reference may be bodily incorporated into the structure of the primary reference.... Rather, the test is what the combined teachings of those references would have suggested to those of ordinary skill in the art." *In re Keller*, 642 F.2d 413, 425, 208 USPQ 871, 881 (CCPA 1981). See also *In re Sneed*, 710 F.2d 1544, 1550, 218 USPQ 385, 389 (Fed. Cir. 1983). It is not necessary that the inventions of the references be physically combinable to render obvious the invention under review." *In re Nievelt*, 482 F.2d 965, 179 USPQ 224, 226 (CCPA 1973). Thus, one cannot show nonobviousness by attacking references individually where the rejections are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208

USPQ 871 (CCPA 1981); *In re Merck & Co.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986).

Conclusion

4. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

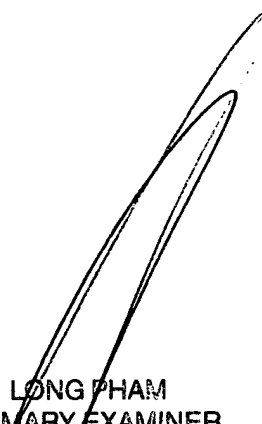
5. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thao X. Le whose telephone number is (571) 272-1708. The examiner can normally be reached on M-F from 8:00 AM - 4:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wael M. Fahmy can be reached on (571) 272 -1705. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Thao X. Le
30 Sept. 2005



LONG PHAM
PRIMARY EXAMINER